Building Energy Information Systems and Performance Monitoring Tools

Technical Advisory Group Meeting

Mary Ann Piette
Jessica Granderson
Girish Ghatikar
Phil Price
Lawrence Berkeley National Laboratory

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http://eis.lbl.gov/

Building Energy Information System Technologies

Agenda

- Members Present
- Project Update
  - Goals and objectives
  - Timeline and status
- Preliminary findings
  - Final form of characterization framework
  - Commercial EIS evaluations
  - Case study highlights
  - Conclusions
  - Future work
- Complementary EIS studies
- Discussion

Project Goals and Objectives

Project Goals

- **Evaluate** EIS and how they support reducing energy use and costs and emissions from energy use
- **Describe** status of technology and improvements in information management systems
- **Consider** how facility operators and energy managers access to energy information
- **Assess** how EIS can improve demand responsiveness and peak demand reductions
- **Analyze** methods to improve energy information links to non-energy issues – maintenance/operations, other resource consumption (e.g. water)

Project Goals and Objectives

Specific Objectives

- **Develop** framework to characterize and classify EIS and PM tools for building energy analysis.
- **Evaluate** and characterize current products, tools, and systems used, and developed for commercial buildings.
- **Develop** evaluation concept for case studies to evaluate how facility uses existing and emerging tools
- **Support** state buildings, monitoring based commissioning
- **Update** 2003 report – “Web-based EIS for Energy Management and Demand Response in Commercial Buildings”

Project Timeline and Status

Completed Tasks

1. Develop characterization framework
2. Evaluate ~35 commercial EIS technologies
3. Conducted UCM, UCB, SYSCO case studies
4. Published preliminary findings

Remaining Tasks

1. Conduct Walmart case study
2. Finalize findings in LBNL report

EIS Definition

EIS comprise

- Software, data acq. hardware, and communication systems
  - To collect, analyze and display building energy information

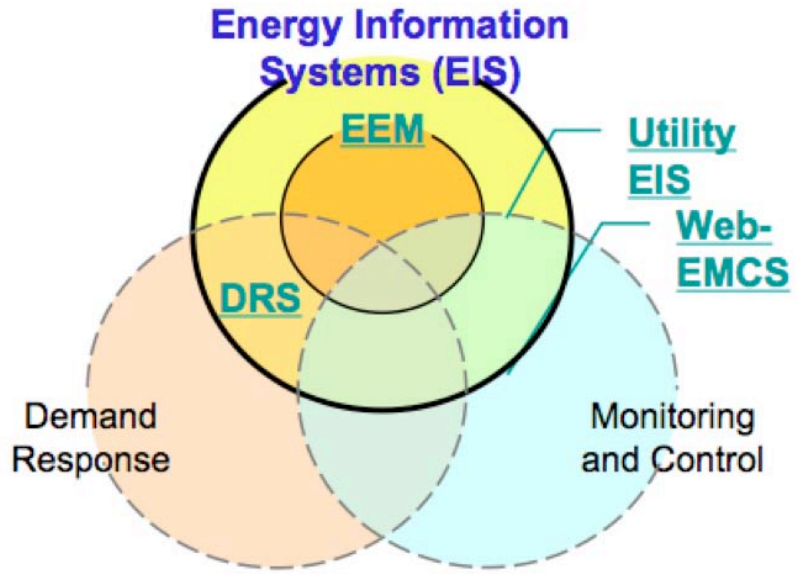
EIS provide

- Web-accessible hourly whole-building electric data
- Analytical and graphical capabilities
- Processed data, i.e., weather, energy price signals, and demand response (DR) information

EIS Definition

Four general types of EIS

1. Utility EIS
2. DR systems,
3. Web-based EMCS
4. Enterprise energy management (EEM) tools

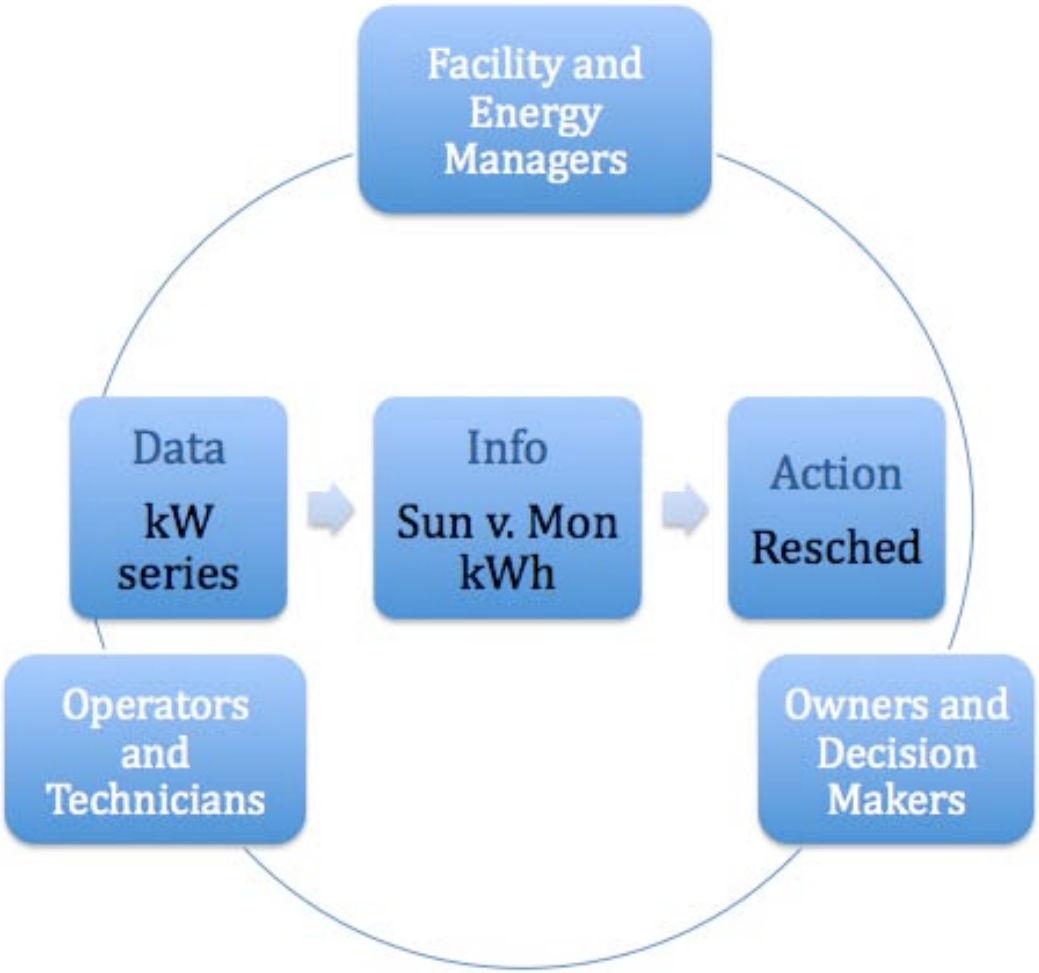


EIS are NOT

- Most EMCS and equipment FDD
- Energy information dashboards
- Batch analysis tools
- GHG footprint calculators

EIS Importance

EIS process *data* into *information*, and provide the informational link between the actors who impact efficiency



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EIS Characterization Framework

8 categories with 5-10 features each

- Data collection, transmission, storage and security
  - Storage capacity, upload frequency, supported protocols and interoperability, archived and exported data formats
- Display and visualization
  - Overlays, plotting intervals, x-y plotting, DR event status
- Energy, financial and advanced analyses
  - Forecasting, benchmarking, costing, renewables, carbon
- Demand response
- Remote control and management
- General info
  - cost, licensing, target users, etc..

Commercial EIS Evaluations

Vendor	EIS
Agilewaves	The Resource Monitor
Apogee Interactive	Commercial Energy Suite
Automated Energy	
Automated Logic	Web-CTRL
Chevron Energy Solutions	Utility Vision
Energy Connect	Web Connect
EnergyICT	EIServer and modules
EnerNOC	Power/CarbonTrak
Envinta	ENTERPRIZE.EM
FactoryIQ	eMetrics
	Green Energy Management System (GEMS)
Gridlogix	Automated Enterprise Management
Interval Data Systems	EnergyWitness
Itron	EEM Suite

Vendor	EIS
Matrikon	Operational Insight
NorthWrite	Energy WorkSite
Novar	
Noveda	Facilimetrix
Powerit Solutions	Spara EMS
PowerLogic	Energy Profiler Online
PowerLogic	Ion EEM
Richards Zeta	Mediator
SAIC	Enterprise Energy Dashboard (E2D)
Small Energy Group	Pulse Energy
Stonewater Controls	InSpire
Tridium	Vykon Energy Suite
Ziphany	Energy operation, information, DR platforms

EIS Business Models

- Difficult to map EIS to traditional software business models
  - Standard software products, enterprise client-server applications, SaaS/ASP and turnkey solutions
  - Optional services, customization, data and IT management, pricing variants blur lines between models

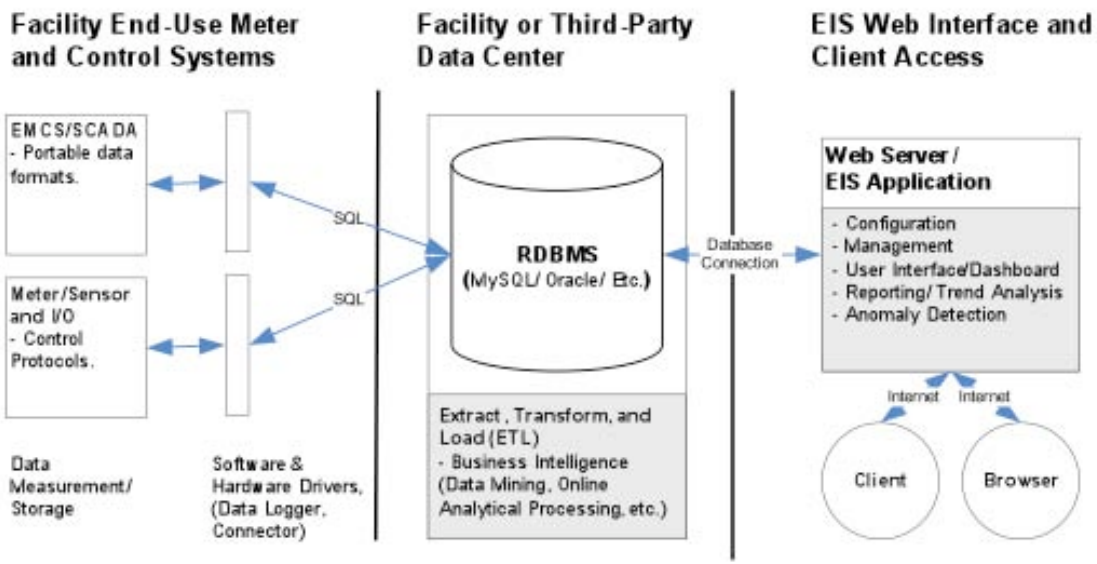
Trends

- Commonly SaaS, no/optional hardware based on client needs, rarely client-server apps
- Services are frequently optional or bundled
- Some EIS are free, offered with energy analysis service agreements, or large utility customers

EIS Architectures

Three typical layers comprise EIS architectures

- Facility Meter and Control Systems measure loads using protocols such as BACnet, and Modbus
- Data Center to warehouse EIS trend data
- Web Interface



Evaluation Findings, State of Technology

Display and visualization

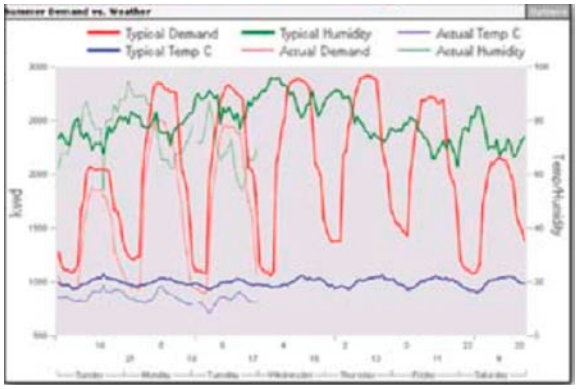
- Load profiling, point overlay, and aggregate totaling are widely accommodated
- X-y scatter plotting is under-supported
- Flexibility varies: display parameters dynamically altered ‘on-demand’, or statically defined in configurable options
- Display of DR event status universally supported in DR tools

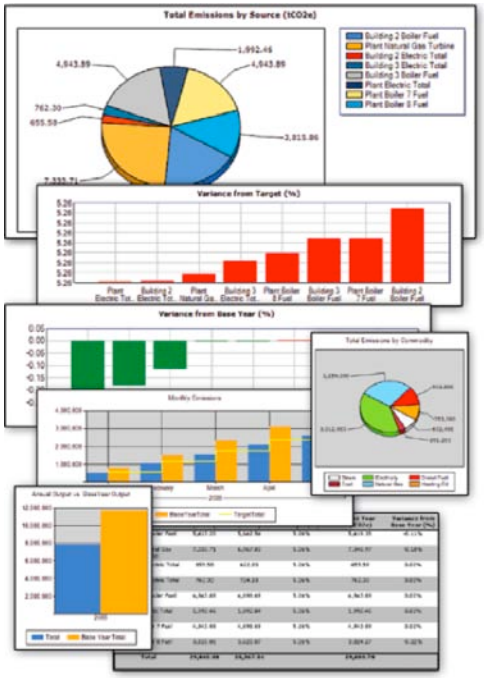
Evaluation Findings, State of Technology

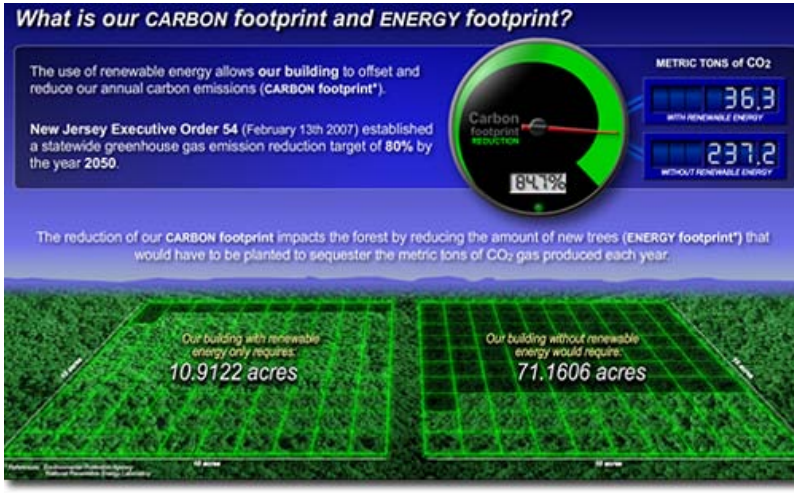
Energy Analysis

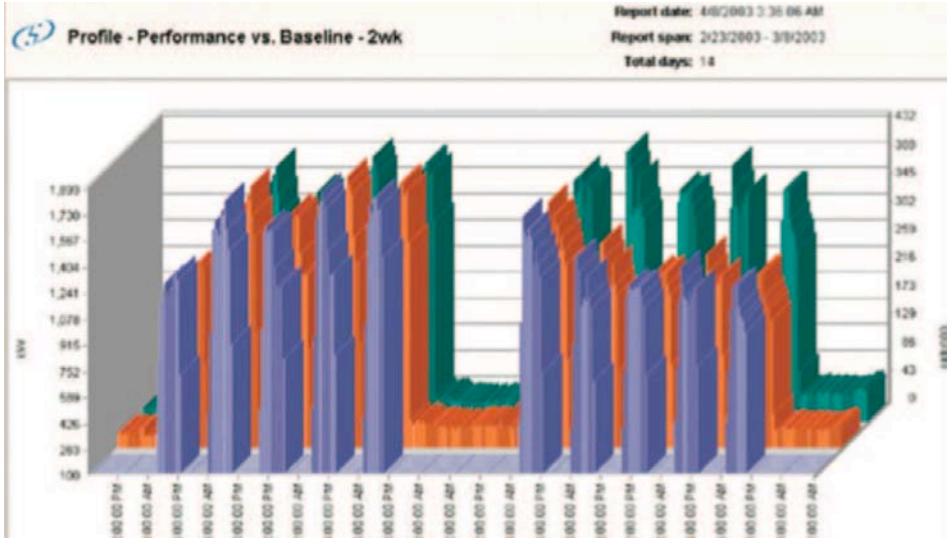
- 2/3 feature carbon tracking and analysis, or configurable options
  - The majority apply a simple energy/CO_2 relationship
  - About half use regional generation stats, other standards
- Normalization is common, rigor varies
  - Defined arithmetic, reports, trends based on other trends
- Historic baselining and multi-site benchmarking are nearly universal
  - Trend or report-based, less often weather-normalized
  - 2 examples of benchmarking against national data sets (IDS uses CBECS and NorthWrite uses Energy Star)

Display and Energy Analysis Screen Shots





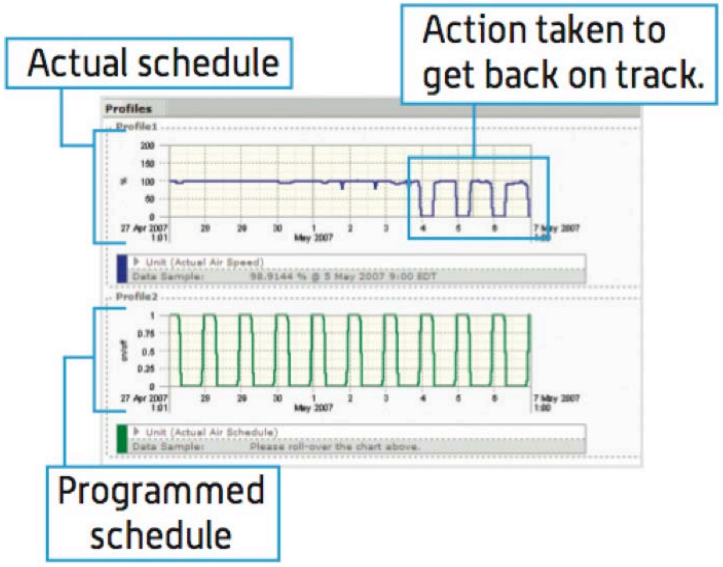




Evaluation Findings, State of Technology

Financial and Advanced Energy Analysis

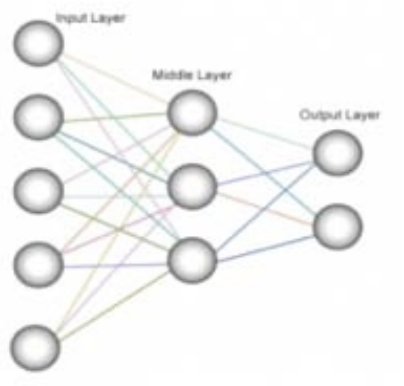
- Corrupted data –flagged or reported; cleansing or correction; link to external software
- Anomaly detection via departures from normal consumption or trend patterns
- FDD rare, some link to 3rd party

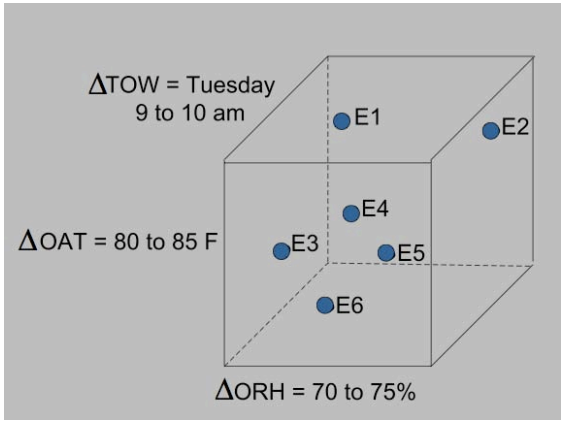


Evaluation Findings, State of Technology

Financial and Advanced Energy Analysis

- Tariff-based costing in ~half the EIS surveyed
  - DR tools of most robust for energy costing
- >half provide forecasting, typically historic trends + weather data, perhaps pricing or cost data
  - EnergyICT uses NN, NorthWrite uses bin methodology





Evaluation Findings, State of Technology

Control and Demand Response

- >half control according to a program via gateway or EMCS
- <half report internet-capable remote control
- DR capabilities have advanced since 2003, converging to a common set of features
  - Auto-DR, electronic notification, utility baseline calculation, response recording, opt/black out dates
- Predicted savings from response is distinguishing feature of today's DR tools

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EIS Case Studies

Motivating Questions

- Which features have proved most useful in attaining energy savings?
- What actions are taken based on the information provided via an EIS?
- How much of a building's energy savings can be attributed to the use of an EIS?

Selection Criteria

- Engaged EIS users with a role in commercial energy management
- Aggressive energy savings

UC Merced

Campus Features

- 2005 opening, newest UC campus 800,000 sf, 4 main buildings, central plant, housing/dining

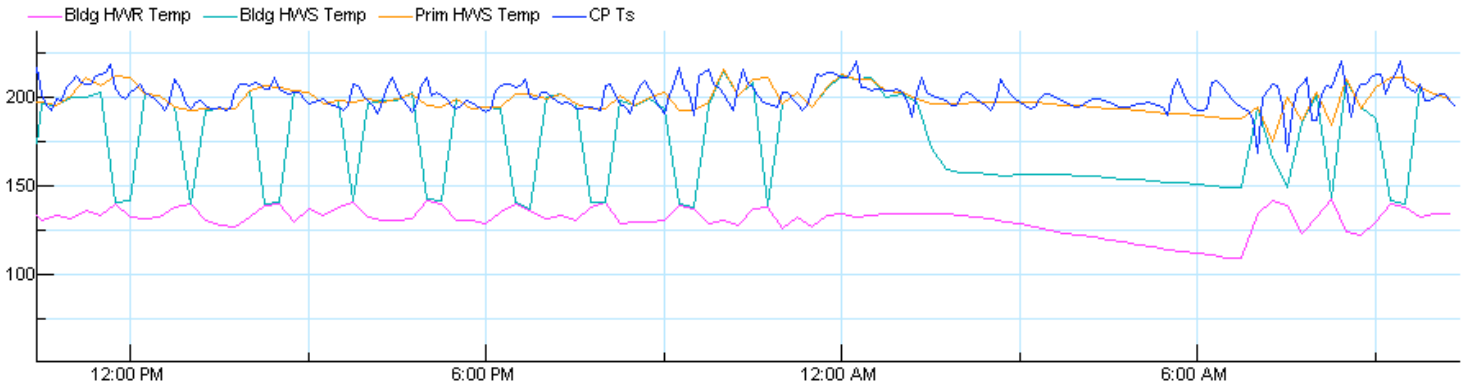
Energy Targets

- Efficiency prioritized in design stages
- Goals: 20% better than benchmark, ramping to 35%

UC Merced

Automated Logic Web-CTRL

- Selected for web connectivity, remote monitoring and control capabilities
- EIS uses: energy performance tracking, assessment of utility recharges
- EMCS uses: Building, equipment troubleshooting



UC Merced

Actions from EIS information

- Steam plant trends to identify excessive overnight steam plant pressure (~35% reduction in gas)
- Gas trends and local steam measures to support De-Cxing central steam plant

2007-2008 Energy Performance

	Campus Gas	Campus Electric	Campus Pk. Demand	Building Electric	Building Pk. Demand	Building Pk. Cooling
Improvement vs. benchmark	27%	34%	37-52%	39-48%	54-55%	16-36%

EIS Challenges

- Network reliability - data corruption, equipment lock-out and false alarming
- Features – no x/y scatter plotting
- Logic-based arithmetic limits automation of identification, correction of corrupt data
- Staffing, resources
  - Uniformity in trend-log sampling rates
  - Distributor relationship and need for EIS changes
  - Regular energy analysis beyond EMCS troubleshooting

UC Merced

EIS Strengths

- Plotting and navigation of large data sets (vs. Excel)
- No superfluous unused features
- Realization of UCM as a '***Living Laboratory***'
- Energy manager's implementation wish-list can be accommodated with WebCTRL features

EIS Perspectives

- Prefers accepting limitations of single tool over using a suite of tools
- Need to **link performance and maintenance** – decision support to protect efficiency investments

SYSCO

Corporate Energy Efficiency Program

- Goal - 25% savings enterprise wide in 3 yrs
- EIS modules developed in part for SYSCO needs
- NorthWrite EIS + Cascade Energy Eng. services
  - EIS used on-site, and throughout corporate enterprise
  - ‘Energy champion’ accountable for energy performance and rankings
- Expert audits + EIS data → low/no-cost measures
- Capital improvements over time
- 28% savings achieved after 2.5 yrs (18% low/no)

SYGMA

Site Features

- Northern CA Stockton distribution center
- 3 warehouse buildings – refrigerated (748 ft^3) and frozen (595 ft^3) space, dry goods, office
- Old systems w/ virtually no controls
  - Dial-up DOS cmds for refrigeration systems
  - Considering Ingersoll Einstein II

Metering

- 5 utility meters, 15-min pulses to central server via cellular, moving to RT
- Op and shift changes easily seen in bldg meters (50% refrigeration, 20% lighting)

SYGMA

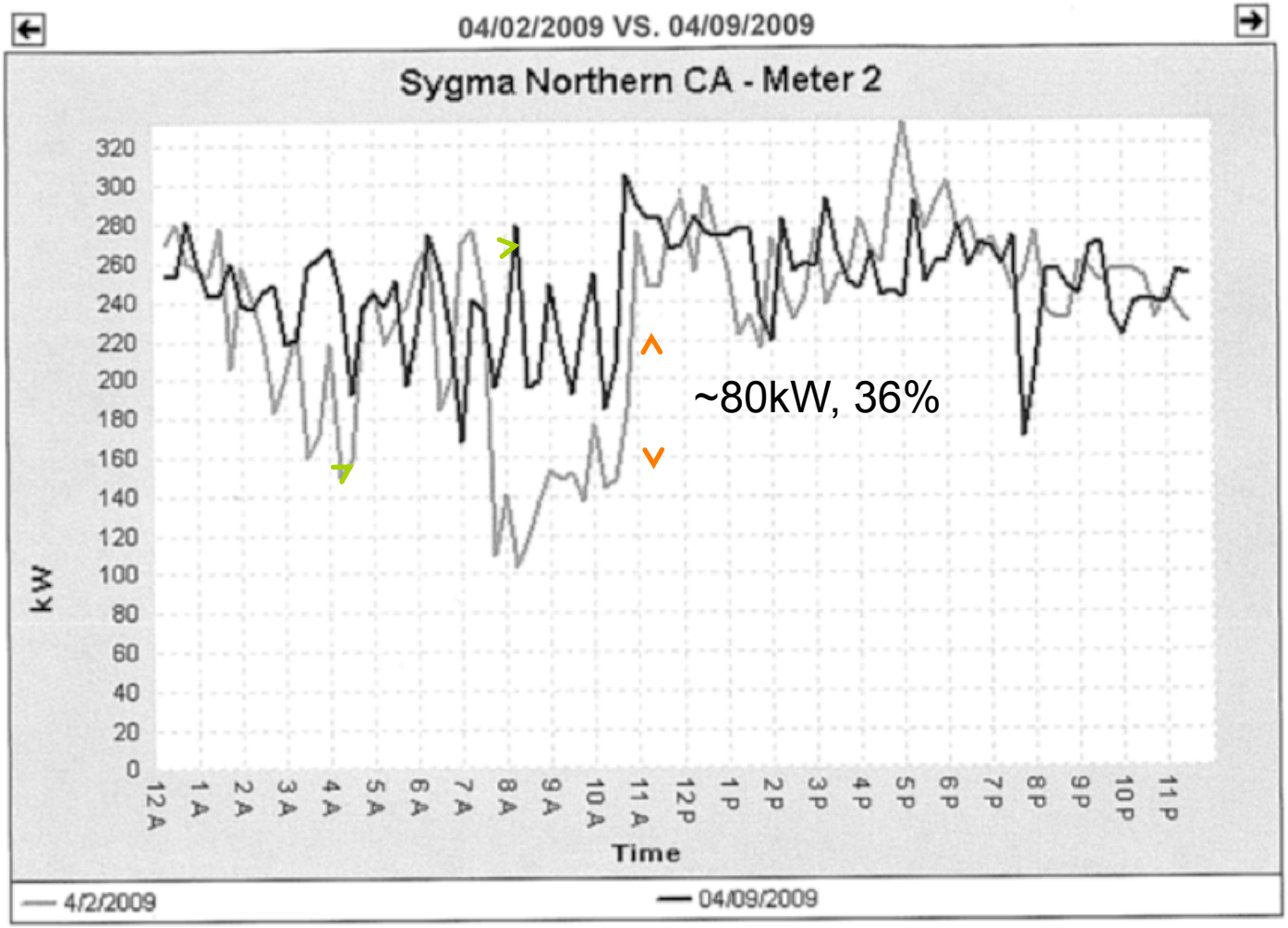
Daily On-site EIS Use

- Limited yet powerful use of EIS features
- 95% of use – 1 meter (refrigeration), 1 view
  - Today/this week vs. last week, % change in use, temperature change
- Daily, manual load reduction at 10 units
  - Systems will run 24/7 but don't have to
  - ~7AM setpoints raised to force compressors off
  - Temperatures monitored throughout AM
  - Setpoints lowered to normal ~11AM

Electric Demand

Energy champ on vacation

Daily load reduction



Anchor Graph at Zero

04/09/2009: **5,873 kW**
04/02/2009: **5,567 kW**
Change: **5.5%**

04/09/2009 Average Ambient: **53°F**
04/02/2009 Average Ambient: **57°F**
Temp Change: **-4°F**

SYGMA

Monthly EIS Use

- Ensure loads drop as expected off-hours (lights)
- NorthWrite reports to generate site rankings
  - Review meetings w/ project mgr and energy champions
  - Accountability mechanism
  - Culture of competition
- Efficiency factor is primary metric
  - EF = f (wet bulb, kWh/dy, kWh, ft^3 frozen, ft^3 refrig.)
  - Monthly ranking tables
  - Color-coded tables to show up/down from prior mo.
- Automatically generated utility reporting (lags)

Monthly Ranking Tables

Ranking Table Report - January 2009

North Central

Ranking Table		
Rank	Site	Efficiency Factor
1	GRAND RAPIDS	0.521
2	KNOXVILLE	0.525
3	CINCINNATI	0.577
4	BARABOO	0.676
5	CLEVELAND	0.687
6	ROBERT ORR	0.712
7	ASIAN FOODS - Chicago	0.738
8	E. WISCONSIN	0.742
9	INDIANAPOLIS	0.763
10	KANSAS CITY	0.811
11	MINNESOTA	0.829
12	ROBERTS	0.849
13	HARDINS	0.858
14	NORTH DAKOTA	0.864
15	DETROIT	0.865
16	IOWA	0.867
17	ST. LOUIS	0.920
18	LOUISVILLE	0.956
19	PEGLER	0.959
20	CHICAGO	1.118
21	CENTRAL OHIO	1.500
22	ASIAN FOODS - St. Paul	1.665
	AVERAGE	**0.864**

SYGMA

Ranking Table		
Rank	Site	Efficiency Factor
1	Sygma - Denver	0.625
2	Sygma - Southern California	0.663
3	Sygma - Northern California	0.671
4	Sygma - Portland	0.822
5	Sygma - Oklahoma	0.864
6	Sygma - Dallas	0.867
7	Sygma - Kansas City	0.926
8	Sygma - Detroit	0.982
9	Sygma - Illinois	0.983
10	Sygma - Georgia	1.015
11	Sygma - Boston	1.059
12	Sygma - Pennsylvania	1.070
13	Sygma - Florida	1.097
14	Sygma - Carolina	1.125
15	Sygma - San Antonio	1.555
16	Sygma - Columbus	2.209
	AVERAGE	**0.955**

SYGMA

Unused Features

- Nearly all functionality is unexplored
  - Benchmarking, utility bill analysis, energy reporting, facility data …
- Features not understood
  - Utility analysis limited to use only, no cost (incorrect)
  - Difficulty locating meter views other than default – ex. last year's peak, several months of time series

Site-Specific EIS Perspectives

- Couldn't do energy champion job w/o EIS
  - Power is in motivation, accounting, persistence, verification

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Key Findings

Distinguishing Characteristics

- Dynamic vs. static definition of reporting, calculation, and plotting parameters
- Rigor in energy analyses - normalization, standards-based calculations, actionable anomaly detection, and forecasting robustness varies

Success Models

- Large enterprises and campuses have demonstrated successful cost-effective EIS use
- What other models for small-medium commercial?
  - Organizational resourcing – onsite vs. service contracted analysis?

Key Findings

Choosing the ‘best EIS’ for a given application

- Begin w/ site operational and energy goals to understand immediate and long-term needs
- ID high-priority features and functionality
- Select most appropriate technology
- An org. w/ tailored benchmark models might prioritize flexible definition of metrics, over dynamic configuration
- A large enterprise that requires proof of retrofit savings may value robust baselining, data cleansing, and tariff-specific energy costing

Future Work

Usability

- Unclear that all users know how to use EIS features to transform time series data into energy-saving information (case studies, utility anecdotes)
- Case studies gave insights, yet several questions require merit further attention
  - To what extent are the features in the framework used, and for what purposes?
  - Which features are potentially useful but underutilized or not available?
  - How can existing functionality be made more valuable?

Future Work

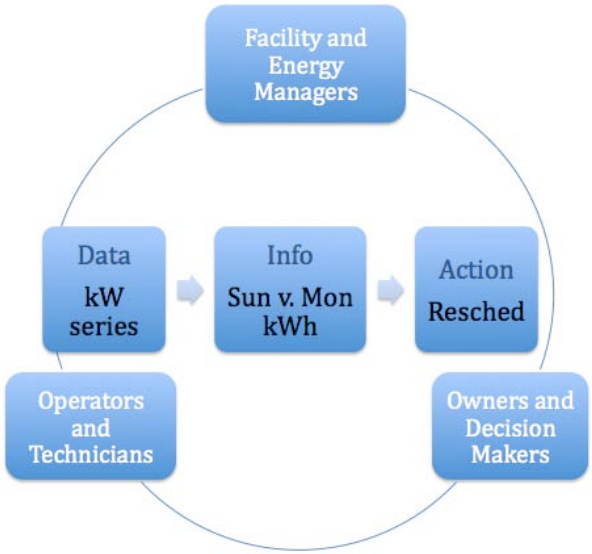
Standardization

- Common metrics, e.g., weather-normalized EUIs, and time series analyses are required
  - Energy use and building performance can be then communicated across owners, throughout the commercial building industry

Future Work

Standardization

- Need to migrate stakeholders to common language
  - An operator may view time series to determine that a chiller is not running according to the off-hours schedule,
  - An energy manager may observe unexpected changes in load duration
  - An owner may note rises in off-peak energy costs



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Complementary EIS Studies

New Buildings Institute

- EPA report *"Advanced Metering and EIS"*

LBNL DOE (w/ NBI)

- National accounts focus, retail and hospital case studies

PECI

- CA state funding, initial scoping/definition (?)

UC Berkeley CBE

- Focus on software for building occupants